Science and Practice of Integral Waterproofing

as applied to Basements, Cement Stucco, Reservoirs, Cisterns, Tunnels, Stand-Pipes, Foundations, Subways, and Masonry Structures of all kinds.

THE TRUSCON LABORATORIES
DETROIT, MICH.

Science and Practice of Integral Waterproofing

Contents

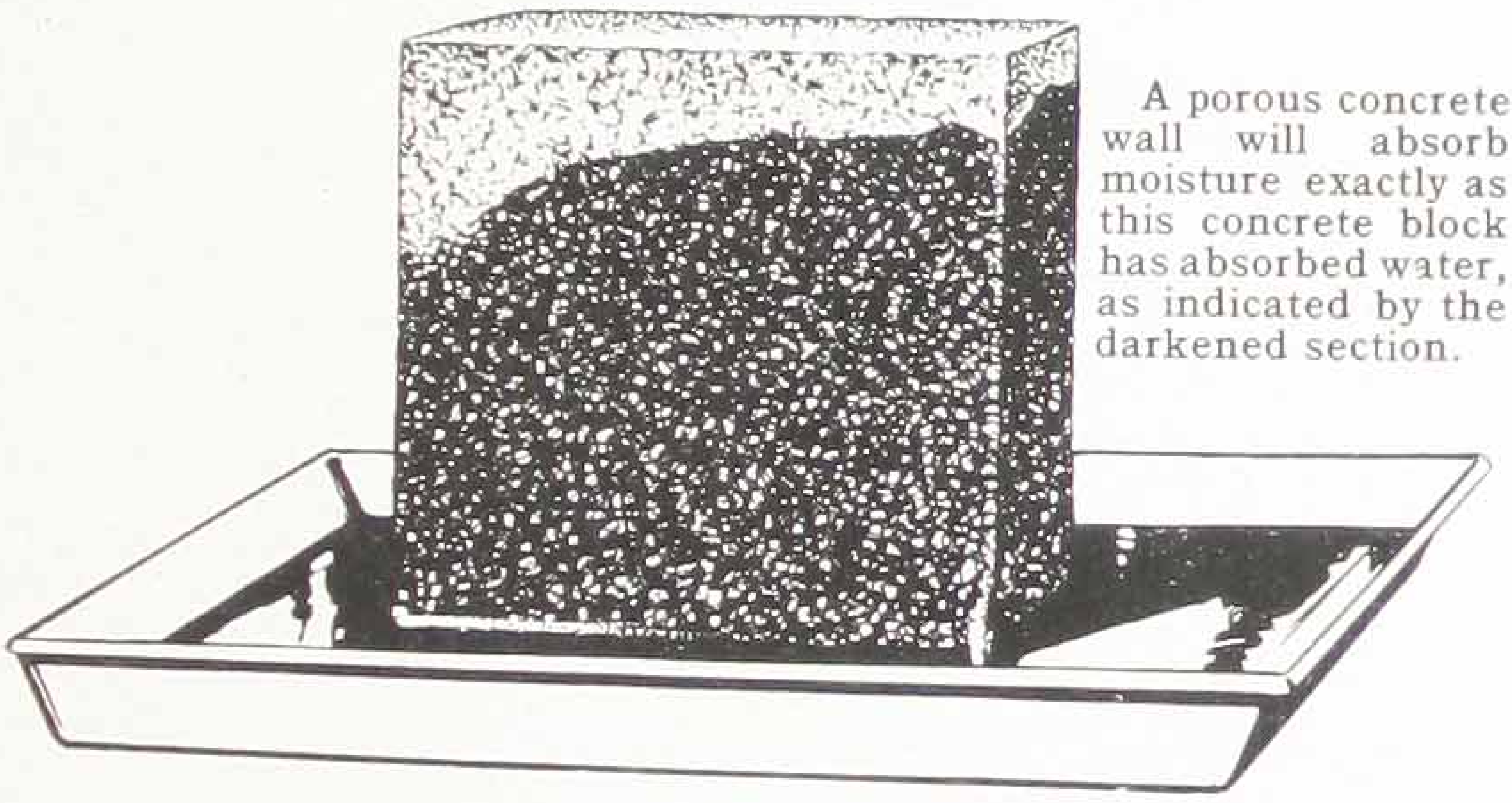
PREFATORY NOTE

The Integral Method of waterproofing concrete is so designated because it actually waterproofs the concrete integrally It renders the structure itself inherently waterproof. This sharply differentiates the method of waterproofing with TRUSCON WATERPROOFING PASTE, CONCENTRATED from any method of waterproofing by the application of materials, such as various coatings, bitumens with and without felt, etc., which however, do not confer any inherent waterproofness to the structure itself.

Science and Practice of Integral Waterproofing

Why Concrete Requires Waterproofing

The peculiar structure and formation of concrete is responsible for its ready absorption of water. A block of concrete set in a pan of water, as shown in the illustration, with 4 or 5 inches of its upper section entirely clear of the liquid, will in a short time absorb a considerable volume of



A porous concrete wall will absorb moisture exactly as this concrete block has absorbed water, as indicated by the darkened section.

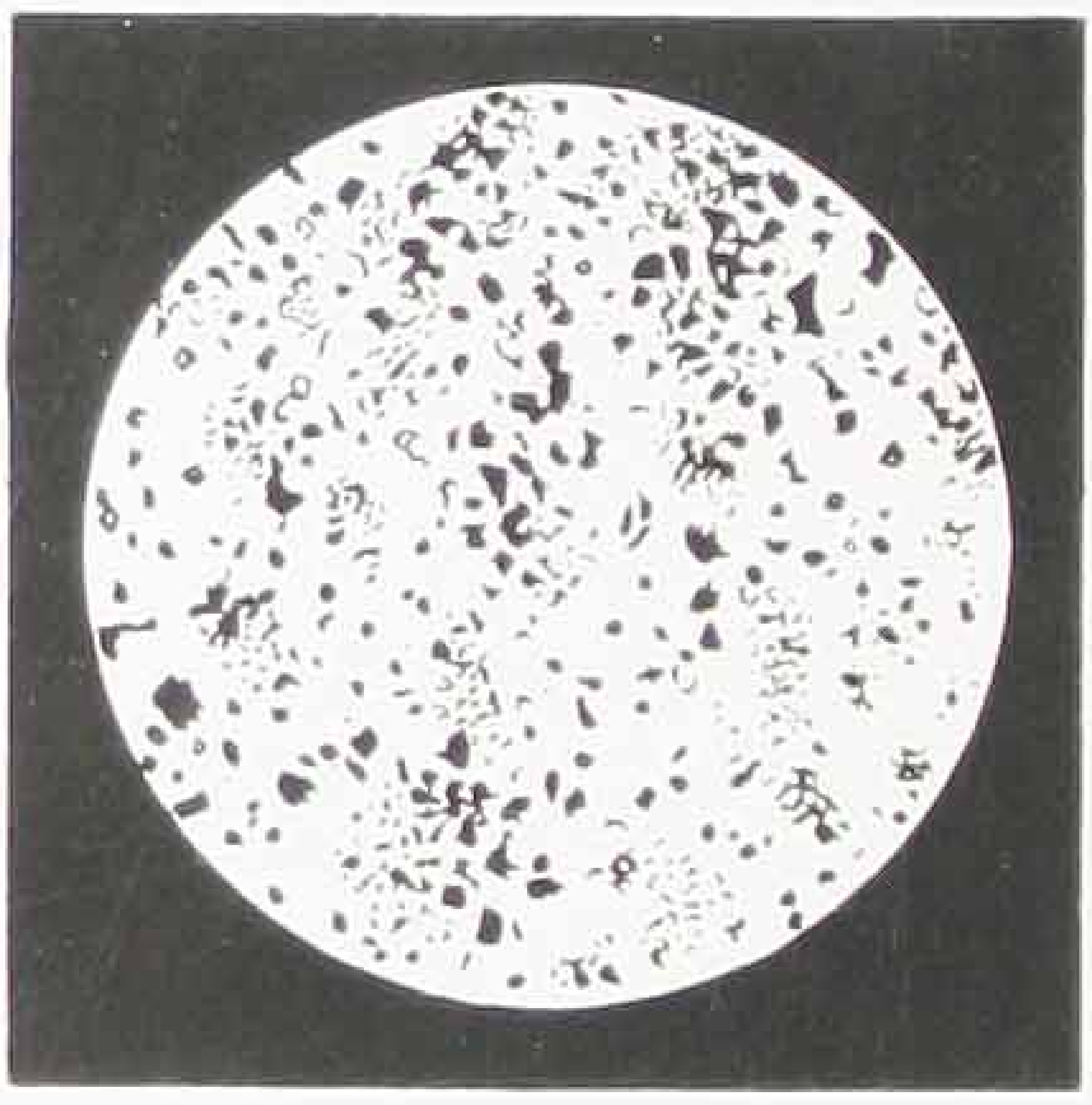
water. This absorption is not by any means confined to that section of the concrete immersed in the water but becomes apparent even in that section of the concrete *above* the water level. The water rises into the structure of the concrete just as it would rise in a wick, except that it takes a little more time.

Concrete Is Porous

The same absorption of water applies to a concrete wall or floor—the concrete will absorb or drink up the moisture directly out of the ground. Where the soil moisture is comparatively slight, there is a correspondingly small amount of absorption, with the result of an apparently dry basement. But when this moisture increases as

a consequence of rains or other physical conditions, dampness or seepage immediately make themselves apparent.

However, seepage, or the actual appearance of wetness are not always necessary as visible evidence of a damp structure. For instance, a cement basement may be very damp without showing any evidence of water at all. This is especially true if the basement is well ventilated —the moisture then evaporates so rapidly as to leave no darkening or wet effect on the concrete. In a case like this, however, all that is necessary to prove the existence of water is to lay a rubber mat, a piece of linoleum, or other impervious material on the floor for a day or two. At the end of that time the under side of the mat will have become very damp, indicating the presence of moisture. All this moisture of course, is absorbed directly out of the ground.



Reproduction of a micro-photograph of a cement surface showing the porous nature of this material.

The reason for this water-absorptive property of concrete is due to its porous nature. Contrary to the usual opinion and despite its solid and substantial appearance, a block of concrete is permeated with countless microscopic pin holes or pores.

Why Should Concrete Be Porous?

Every man experienced in the handling of concrete knows that for the proper mixing of this material it is necessary to use an amount of water considerably *in excess* of what is actually required for its setting and hardening. This excess of water is necessary for the proper tempering, and particularly for the placing and compacting of the concrete.

Water in Excess of What Is Necessary for Hydration

As an example, a cubic yard of concrete requires on an average about 30 gallons of water to produce the consistency that is most practical for the mixing and placing of concrete. But of this 30 gallons only from 35 to 40 per cent, at the most, is actually required for the process of the setting and hardening of the concrete. On this basis only about 12 gallons of the original 30 gallons of water is retained as a part of the concrete.

Water Evaporates Without Diminishing Volume of Concrete

What happens to the other 18 gallons? A little may be lost in the mixing and pouring, but the greater portion of the 18 gallons actually evaporates while the concrete is drying out.

Now, the volume of the concrete itself doesn't shrink appreciably or grow less as a result of having lost all this water. We still have approximately the same *volume* of concrete after it has set and dried out as at the time of placing. Yet it has lost 18 gallons of water, which formerly occupied 2½ cu. ft. of space out of a total of 27 cu. ft. in that cubic yard of concrete. This 2½ cu. ft. of water could never have been squeezed or compacted into that cubic yard of concrete in the first place, because water is incompressible and occupies very definite and determinable space. Two and a half cu. ft. of water is two and a half cu. ft., and you can't make it any less. And so are all the other materials entering into the making of concrete under these conditions, incompressible.

Loss of Water Responsible for Pores in Concrete

There is only one answer in explanation of this behavior and that is that the concrete after drying out and losing this weight of water is not as dense as it was at the time of being placed—that the space formerly occupied so uniformly by water throughout the mass of this cubic yard is now empty.

This does not mean that the concrete must be full of holes. On the contrary, holes, when they do occur in concrete, are air bubbles or porous

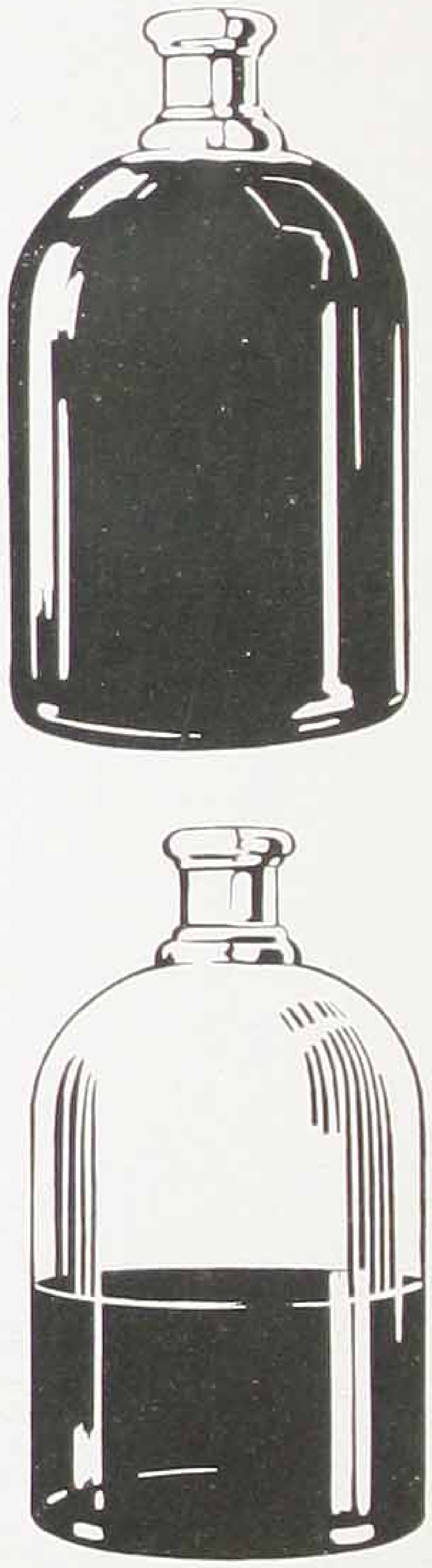
imperfections, and are due to poor placing. A cross-section of a good piece of concrete should show an even solid texture. But when examined under the microscope it is observed that concrete is very porous. It is therefore evident that these microscopic pores or voids represent the space formerly occupied by the incompressible water in the concrete which has since escaped by evaporation.

It is the presence of these pores that imparts the natural absorbent qualities to concrete—its

As an illustration: If this much water is used for thoroughly mixing and placing a batch of concrete—

(See page 5.)

THEN this much probably evaporates. This evaporation of water, which formerly occupied space in the concrete, naturally leaves voids, which accounts for the porous nature of concrete.



ability to raise water above its own level—in other words, what is known as the capillarity structure of concrete.

Peculiar Behavior of Pores in Respect to Water

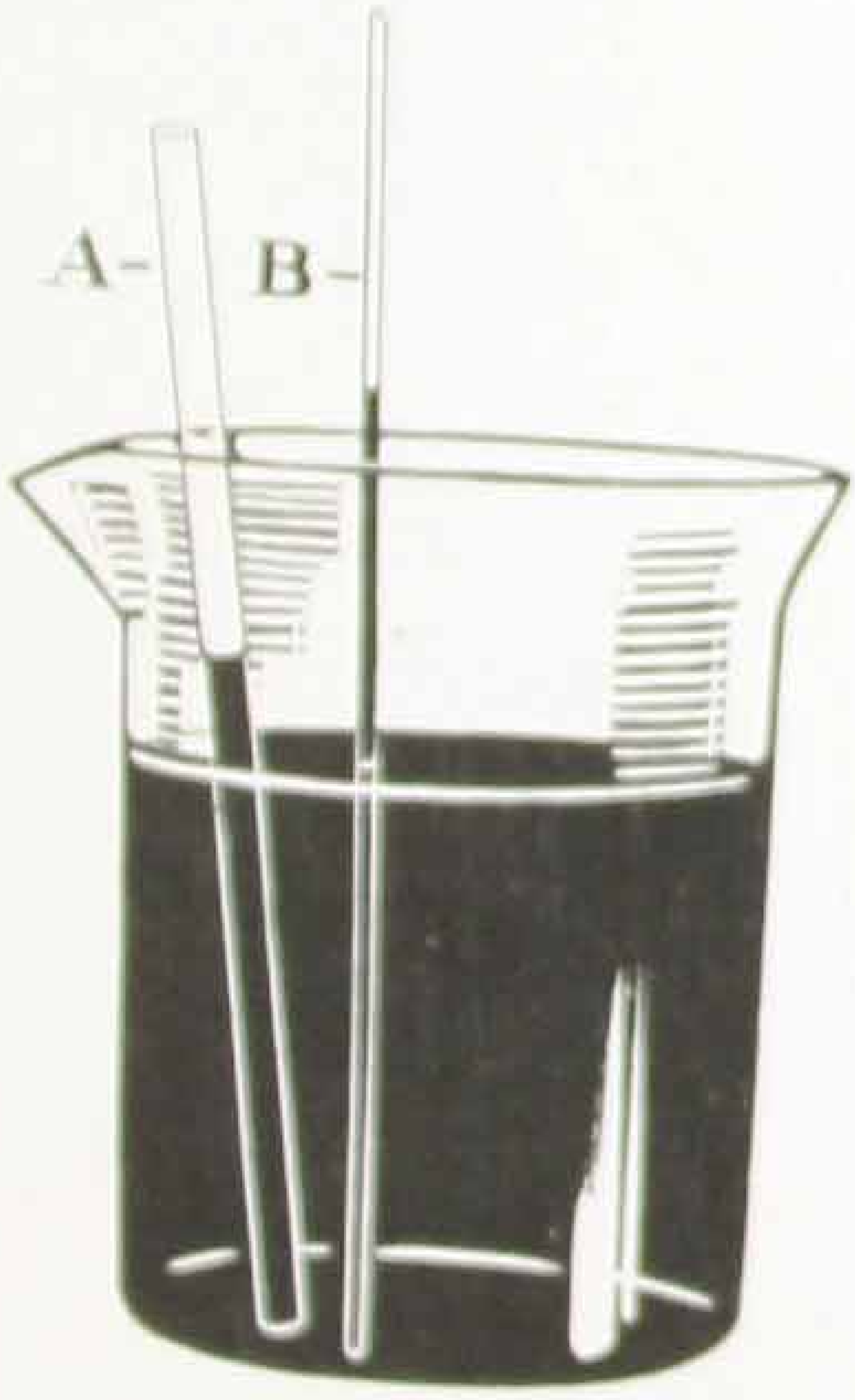
A pore has the quality of acting in a very peculiar and characteristic manner in the presence of

water. Not only does it allow for the *entrance* of water, but it actually *draws up* water into its structure. It seems almost to defy the law of gravitation by forcing water to "run up hill," since water in a pore rises far above its own level.

This is very easily demonstrated in a practical way by placing a glass tube of about 1/8" diameter, open at both ends, into a tumbler of water. It will immediately be observed that the water in the tube *rises higher* than the level of the water in the tumbler. If now one were to take another glass tube, smaller in diameter than the first, and to place this tube in the same glass of water, it will be seen that the water in this tube *rises to a still greater* height than the water in the larger tube. This demonstrates that the finer the tube the greater its suction or power to "draw up" water.

Positive Capillarity

From this we can conclude that if it were possible to make a glass tube of a diameter as small as a pore in concrete, and to observe its behavior when placed in a glass of water, that water would rise within this tube to an infinitely higher level



Two glass tubes in a tumbler of water. Observe that the water level in tube "A" is higher than the level of the surrounding water in the glass. Also observe that "B"—a tube of smaller diameter than "A," allows the water to rise to an even greater height than the larger tube "A." This demonstrates the law of positive capillarity; namely, that the ratio of elevation of water in a pore or duct is inversely proportioned to the square of the diameter of the tube. Consequently, the pores in concrete being very much smaller in diameter than even the small tube "B," water by this law is able to rise to a correspondingly greater height.

than even our smaller glass tube. This explains why concrete walls often show indications of moisture as much as 20 feet above the ground level. The water is simply absorbed out of the ground by positive capillarity and creeps up into the structure of the concrete.

If one considers that the "pores" in concrete are not only many times finer than the diameter of even our small glass tube but that there are millions of them, we can understand why concrete absorbs water so greedily. Because, as stated, the smaller the pore, or tube, the greater the height to which water is drawn up into it.

How Concrete Can Most Effectively Be Waterproofed

The question now is, how to stop this absorption? Obviously, a first impression might suggest plugging the pores in some way since it is these pores which are responsible for the absorptive character of concrete.

Impracticability of Plugging Pores With Inert Powder

A little reflection, however, reveals the utter impracticability of this plan as it would be physically impossible to introduce any product which could have the property of swelling or increasing its volume to any extent as the concrete dried out, that would even approximate the volume left vacant by the evaporation of the water. That is why the attempts to use finely divided clay, lime and other similar materials (known as inert powders) are so unsuccessful for waterproofing concrete.

The real solution to this problem is to be found in a simple application of the definitely established law of capillarity. If positive capillarity is the cause of this water absorption, then it is evident that if a means can be found of destroying this capillarity, or making it negative, then we could render the concrete waterproof.

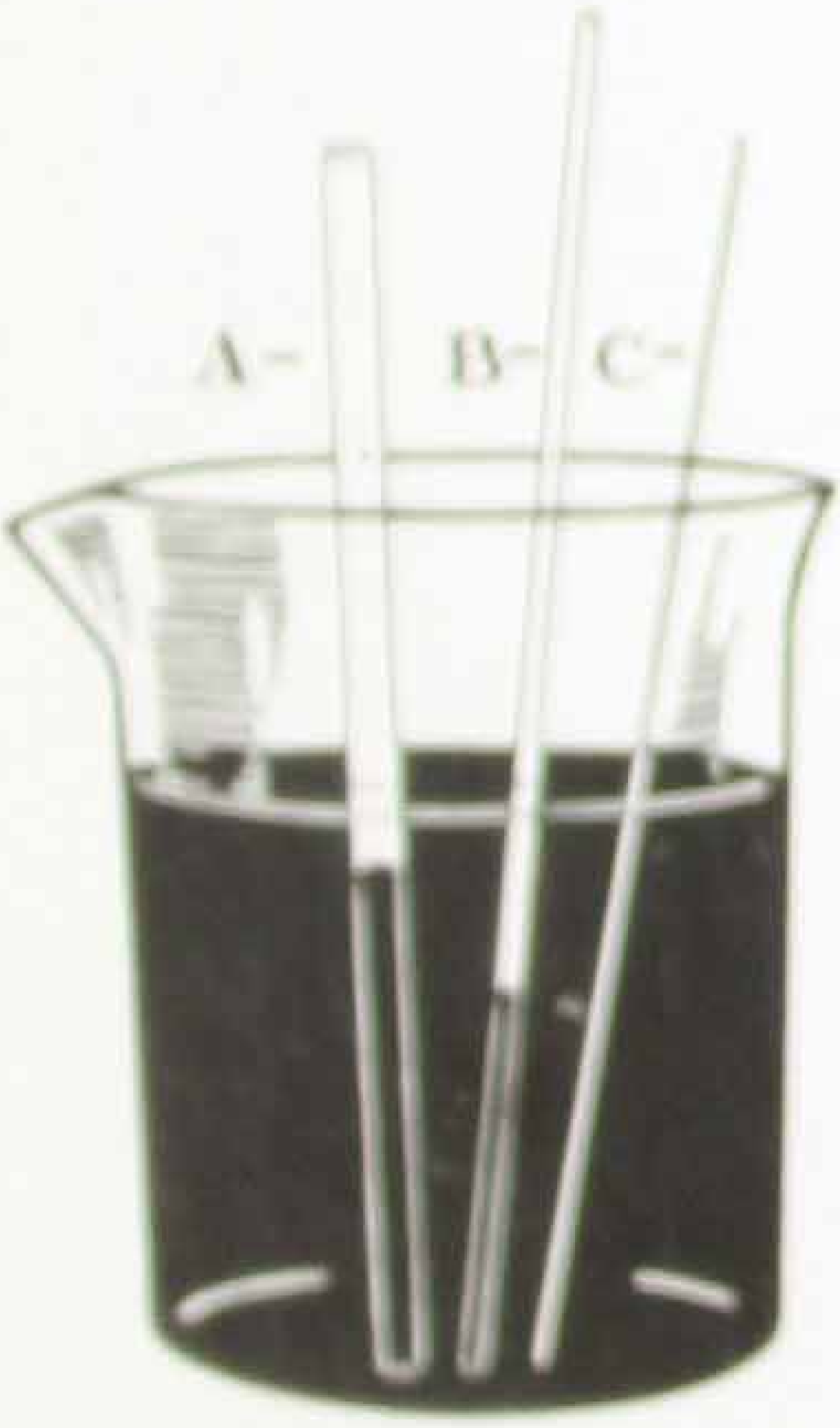
Making Capillary Pores Repellent

It has been observed that water is drawn in or elevated in a tube, as described above, when the water *wets* the inside of the tube. It is also known that when using a liquid that does *not wet* the tube, or when the inner surface of the tube is so treated that the water cannot wet it, then instead of water rising or elevating in the tube, it is actually depressed; a condition described as negative capillarity.

This behavior of water being depressed or repelled when the water *does not wet* the inside or wall of the pore is the exact suggestion of the process to follow to obtain a condition in concrete which will repel the water coming into contact with it rather than drawing it into the mass.

Reason for Efficiency of Truscon Waterproofing Paste

This is very successfully accomplished through the medium of Truscon WATERPROOFING PASTE. Truscon Waterproofing Paste is a material which is mixed thoroughly with the water, the water acting as an agent for the complete and uniform distribution of the waterproofing throughout the entire mass of the concrete. Truscon Waterproofing Paste is present in the water but is not carried out on the evaporation of the water. After the water evaporates the ingredients in the Paste are deposited on the walls of the pores or capillaries and on account of their repellent nature prevent the water from wetting the pore. With this accomplished, instead of water being drawn in, it is repelled or prevented from being drawn in.



Examples *of negative capillarity.* Compare level of water in these tubes with the level of water in tubes on page 7. The difference between the tubes in this figure and the tubes on page 7 is that in this case the walls of the tubes were coated with a water repellent material.

Consequently, when these tubes are placed in a tumbler of water, the water is depressed below its own level instead of being elevated, as in the case of the plain untreated tubes shown on page 7.

The same thing happens when the walls of the pores in cement or concrete are treated with Truscon WATERPROOFING PASTE. The Paste is highly water-repellent, as a result of which the concrete becomes absolutely waterproof.

NOTE.—That the depression of water illustrated is least in "A"—a tube of large diameter, and greatest in "C"—a very fine tube, which demonstrates that negative capillarity, like positive capillarity, (see page 7) is also inversely proportional to the square of the diameter of the tubes or pores.

It is an absolutely established law of capillarity that where the water does not wet the wall of the pore there is no capillarity, and without capillarity there is no absorption. In the absence of absorbency the concrete remains dry.

Nothing could apparently be simpler than this very logical and reasonable solution of counteracting the natural absorbent character of concrete, and yet it is to be noted that the invention and formulation of a material to meet these requirements has occupied the attention of technical men for years.

Many materials were suggested and used from time to time, some apparently giving good results at one time, and proving worthless at another. Naturally, dependability is the big desirable feature in a waterproofing, and no faith can be placed in a material that produces varying results.

The trouble with most of these materials was that from a theoretical point of view they seemed to meet every requirement of a successful waterproofing for concrete, but between the theoretical and the practical application there is often considerable difficulty to be overcome. A waterproofing, to be successful, must work out right not only in the laboratory, but must give unquestioned results in practical field experience.

Truscon the Perfected Waterproofing

In Truscon WATERPROOFING PASTE, Concentrated, you have the *perfected* waterproofing for concrete. It fulfills not only the common sense application of the fundamental principles of waterproofing, but the material, through long experience and use, has been so refined and perfected that as a waterproofing it is practical for use. It not only waterproofs efficiently, but it is easy and simple to use. It is *concentrated,* therefore only a small quantity is required to the cubic yard. It is economical because the cost of the material itself is very low, and it requires no extra labor or experience to place it with the concrete. It mixes readily with the cement and aggregate because it is first added to the water, and since the water becomes so thoroughly distributed throughout the concrete mix, the waterproofing compound becomes equally well distrib-

uted. That is why Truscon WATERPROOFED jobs are thorough and uniformly waterproofed operations. They are operations that give satisfaction even under the most extreme conditions, because the material is highly practical, and its results dependable in every way.

Truscon Paste Convenident an Economical to Use

Right here it should be made clear that although Truscon Waterproofing Paste is introduced into the cement or concrete by being mixed with the water, nevertheless, it *does not dissolve* in the water. This is a very important point since it is evident that a waterproofing that might have a tendency to dissolve in water would very readily be washed out of the concrete and not give permanent results. Or if it reacted with constituents of the cement to form insoluble waterproofing compounds this reaction would materially reduce the strength of the concrete.

Does Not Dissolve in Water

Truscon Waterproofing Paste, because of a process patented by us, is of such chemical com-

Fig. 1

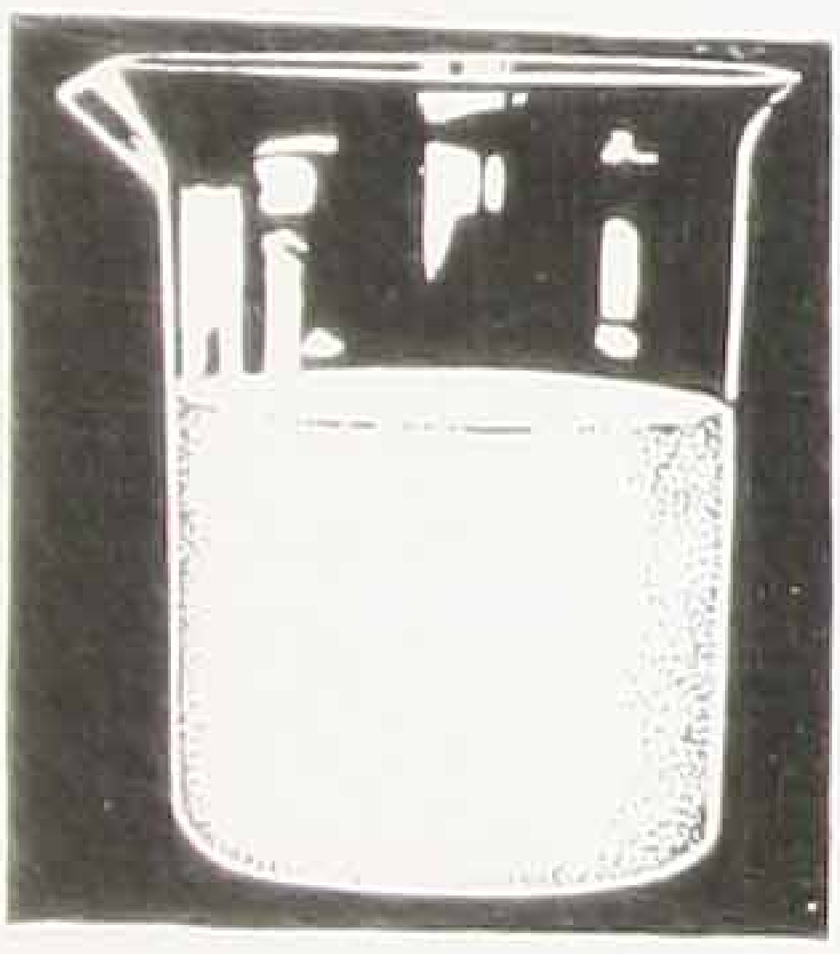


Fig. 2

One way to test the practicability of an integral waterproofing is: Does it mix readily with water? It should, or otherwise the concrete cannot be made uniformly waterproof. In Figure 1, a waterproofing after being stirred in a glass of water and allowed to stand five minutes showed some sediment at the bottom of the glass and considerable material at the surface of the water, indicating very poor distribution which would result in a concrete waterproofed only in spots. Compare the milky appearance of the water, Figure 2, showing how Truscon Waterproofing Paste mixes evenly and uniformly. This means even and uniform waterproofing results throughout the concrete. It emphasizes the dependability of Truscon.

position that it mixes promptly and actively with the water, so that there is no question of its quick

and easy distribution throughout the concrete to be waterproofed. But as soon as the concrete has set, Truscon Waterproofing Paste loses its "easy-mixing-with-water" character and becomes "water repellent," thereby effectively waterproofing the cement or concrete.

A Concentrated Waterproofing

Truscon Waterproofing Paste is *concentrated* —consequently, less is required to the cubic yard for effectively waterproofing cement or concrete. For this reason it is more economical and more satisfactory.

Makes More Durable Concrete

Portland Cement, Plaster of Paris, and all other hydraulic cements, have this point in common: that when mixed with water they undergo what is known as a process of hydration, resulting in the formation of innumerable crystals. It is the inter-lacing and inter-twining of these minute crystals that bonds and ties the particles together, forming the solid structure of all cement.

The hardening of Portland Cement, however, differs from the hardening of a cement such as Plaster of Paris, in that in addition to its crystalline structure, there is also formed a material known as a colloid, which Plaster of Paris lacks. These colloids occupy the spaces in between and around the crystals. They are believed to give to Portland Cement its remarkable durability and capacity for withstanding weather exposures.

This colloidal structure in Portland Cement also gives it a small degree of natural waterproofness. A colloid may be described generally as a material of a jelly or glue-like character. It completely surrounds the crystals, protecting them, and on coming in contact with water, expands, occupying a larger space in the pores, in that way impeding and delaying the natural absorbency of water through capillary attraction; otherwise concrete would be far more absorbent than it is. However, ordinary Portland Cement concrete hasn't a sufficient percentage of the colloid present to establish absolute waterproofness.

In addition to the repellent qualities which Truscon WATERPROOFING PASTE confers on

Portland Cement, it adds to the colloidal quality of the cement, thus introducing an additional factor of water resistancy.

Durable, Waterproof Cement Stucco

Since the colloidal quality of Portland Cement, even in its very small natural percentage, is of distinct advantage to concrete, it is evident that by increasing this colloidal quality, that the weatherproofness and wearing ability of the cement would be correspondingly increased. Such is actually the case, borne out by experience, in that concrete or cement treated with Truscon WATERPROOFING PASTE is far less subject to deterioration by frost, weathering, etc.

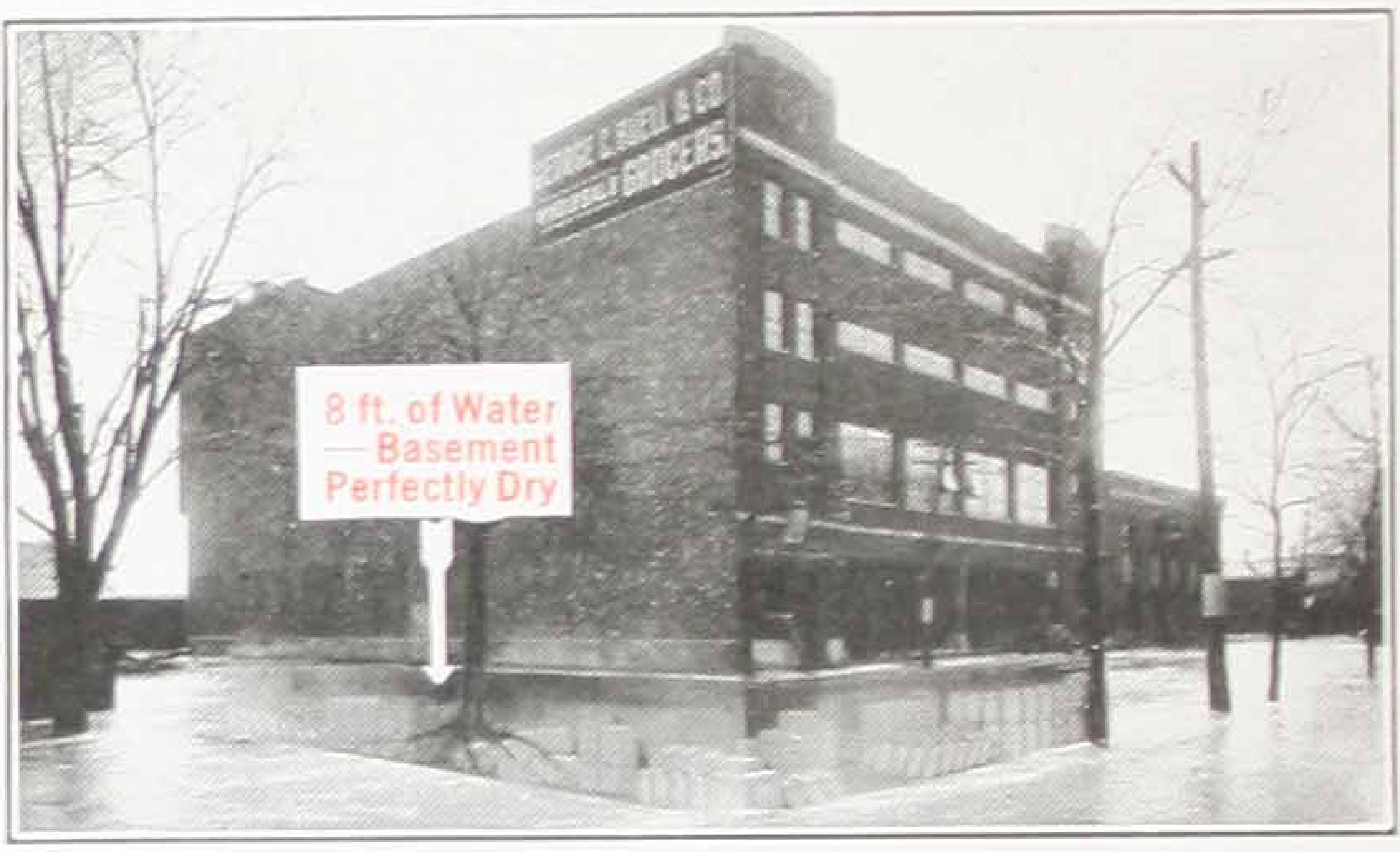
It is this same colloidal quality of Truscon WATERPROOFING PASTE that makes it very valuable for use in cement stucco, which as everyone knows, is highly sensitive to the disintegrative effect of weather exposure. A more durable stucco, as well as a waterproof stucco are obtained through the use of Paste (For Specifications see page 21.)

Insures Denser Concrete

In addition to imparting repellency to the pores of the concrete, Truscon Waterproofing Paste also insures the closer compacting and densifying of the concrete on account of its qualities of reducing and cutting down the surface tension, or weakening the skin strength of the water.

This can be expressed as its quality of lubricating the concrete so that it flows together more readily into a compacter and denser mass. This quality of the surface tension of water can be very simply demonstrated in the general observation of the difficulty of cleansing one's hands, or washing any object, without the use of soap. When no soap is used, water has a tendency to shed itself off the surface with no inclination to spread out and penetrate the dirt. However, as soon as a little soap is used, the water seems immediately to penetrate and to remove the dirt. The function of the soap in this case is simply that of cutting down the surface tension of the water, producing a condition whereby the removal of the dirt or soil has been made easier by

the lubricating action. In concrete the particles of aggregate are permitted to come together into a closer mass through the use of Truscon Waterproofing Paste, and in so doing the inclination to remain apart from adjacent particles is overcome, thereby producing, as already explained, a denser and more compact concrete.



Example of what Truscon Waterproofing Paste did for Geo. C. Buell & Co., Rochester. Their basement used for the storage of merchandise had been waterproofed by the Plaster Coat Method (Pages **17** and **25**) with Truscon Waterproofing Paste. One day the Genessee River overflowed its banks. The Buell Basement, although under a head of **8** feet of water, remained dry as a bone—every other basement in the vicinity was wet or flooded.

The Waterproofing Precaution Should Never Be Overlooked

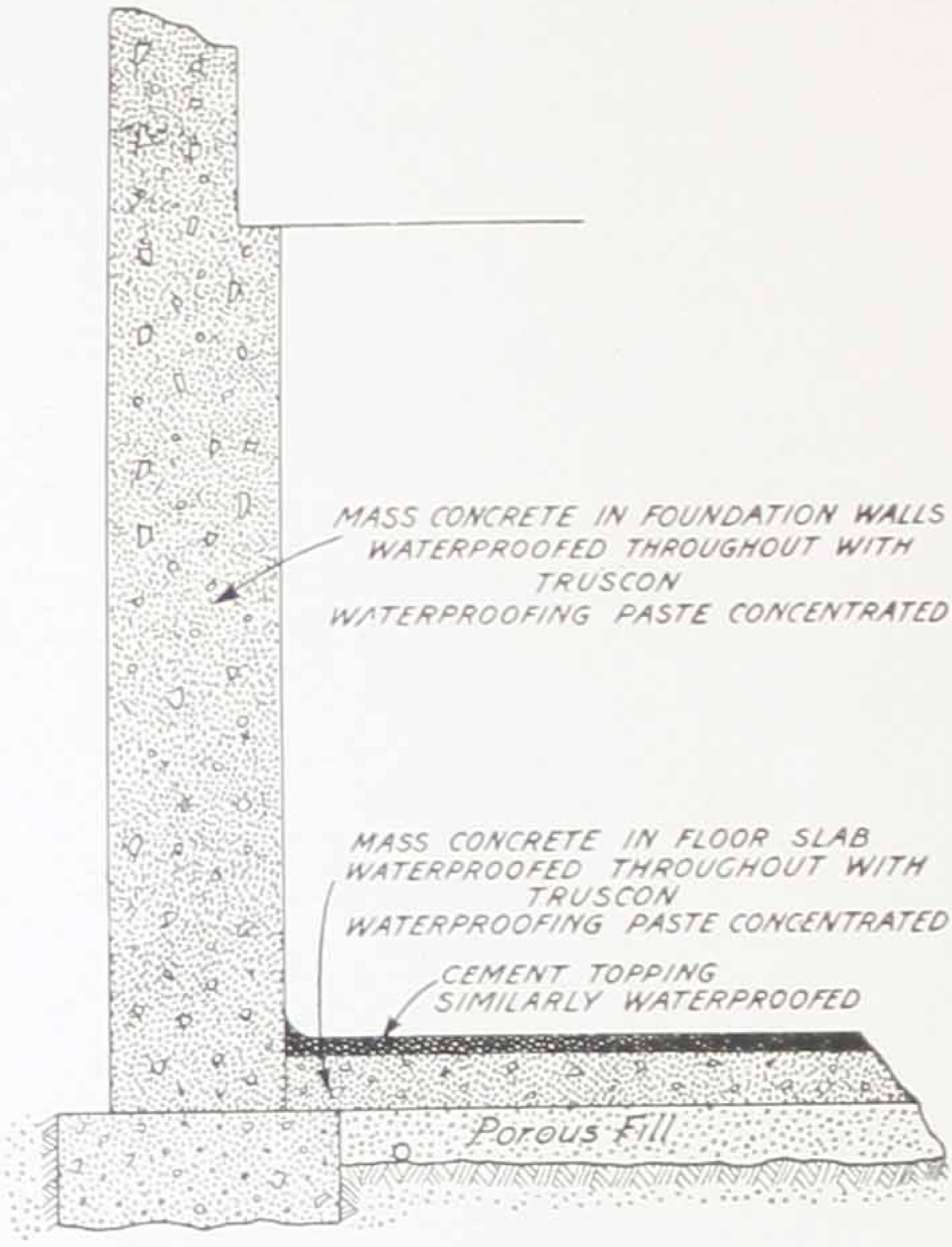
The proof of the desirability of Truscon Waterproofing Paste, Concentrated, is its wide use, especially on the larger and more important building operations. Buildings, running into the millions of dollars, represent too great a risk to permit neglect to the proper waterproofness of their foundations. For this reason Truscon Waterproofing Paste is specified by the leading architects and used by the big contractors on the majority of important operations. Even where such buildings are erected on what appears to be dry ground, it is considered good policy to use Truscon Waterproofing Paste in all undergrade concrete, because it provides a factor of security that is desirable on account of the porous nature of concrete and cement. It should never be considered "well enough" to assume that a concrete foundation may be waterproof merely because the surrounding soil "appears" to be dry.

As the "rubber mat test" referred to on page 4 shows, the surface may "appear" to be dry, when actually there is considerable moisture present.

In the matter of waterproofness appearances are certainly deceiving. It is far safer to *know* than to put reliance on "appearances." Every architect and engineer will take this position.

Truscon Paste Insures Definite Predetermined Waterproofness

On the other hand, where construction is done under conditions where pumps must be kept operating continuously and the water pressure is high, there Truscon Waterproofing Paste likewise proves itself a real essential to the engineer, the contractor, and the building owner. It makes possible bone-dry substructures, even under such adverse conditions.



Waterproofing Mass Concrete by Integral Method

NOTE: This method of waterproofing is applicable to any new concrete operation; concrete basements, concrete tanks, reservoirs, tubes, tunnels, etc.

It is to be noted that waterproofing with Truscon WATERPROOFING PASTE, Concentrated, requires absolutely no change in the original concreting operation except the introduction of the proper quantity of paste to the gauging water. There is no change in the proportions of sand, cement or stone; no change in the mixing, pouring or placing. But the aggregate, instead of being tempered with clear water, is tempered with water into which a definite proportion of Truscon Waterproofing Paste, Concentrated, has been mixed.

Therefore, the specifications we submit on page 17 are simply standard architects' specifications which apply to any first-class concrete operation, except in this case they include the small quantity of waterproofing required.

This explanation is made to avoid the inference that in order to use Truscon WATERPROOFING PASTE special precautions or methods must be employed. No precautions or methods except those which are ordinarily employed in any simple concrete operation are necessary. There is no method easier, simpler or more free from additional labor expense than the incorporation of Truscon WATERPROOFING PASTE into the concrete.

SPECIFICATIONS

For Waterproofing Mass Concrete by Integral Method

Applicable to Standpipes, Cisterns, Reservoirs, Foundations and Similar Structures

1. Intent—It is the intent of these specifications to obtain a watertight concrete structure.

2. Method—Watertightness shall be secured by the addition of TRUSCON Waterproofing Paste, Concentrated, as manufactured by THE TRUSCON LABORATORIES, Detroit, Michigan, to all water used to temper the dry mixture of cement and aggregate, in proportions and mixed as directed below.

3. Ingredients and Proportions for Concrete—The concrete composing the main body of the structure shall consist of one (1) part cement, two (2) parts of sand, and four (4) parts of stone, each to meet the following requirements:

(a) The cement shall be a high grade Portland, which has been carefully tested and found to satisfactorily pass the requirements of the Standard Specifications of The American Society for Testing Materials, and preferably ground so that eighty per cent (80%) shall pass a standard two hundred (200) mesh sieve.

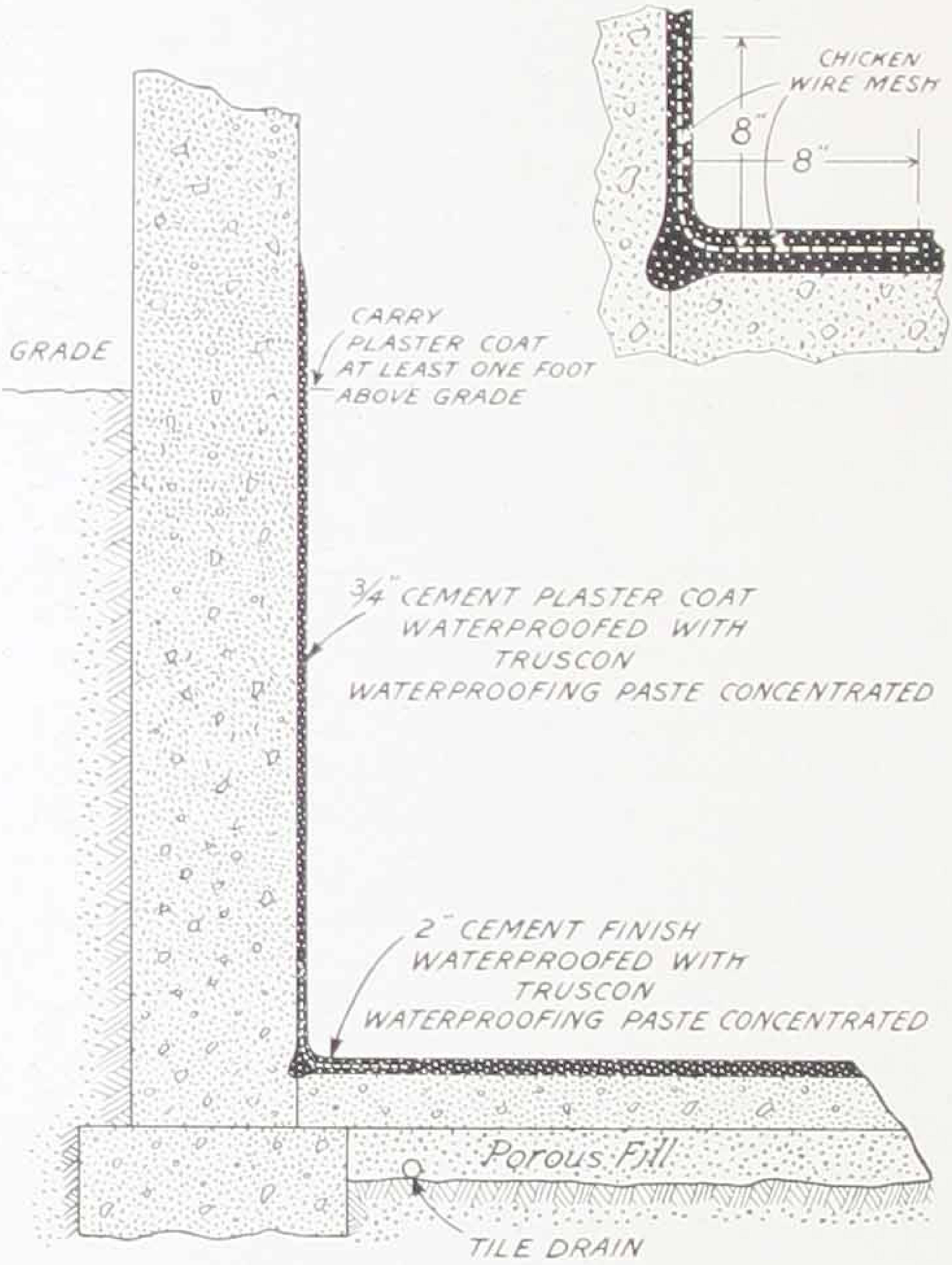
(b) The sand shall consist of spherical grains of any hard rock that is practically free from clay, absolutely free from organic matter, and uniformly graded in size from coarse to fine.

(c) The stone shall be screened from gravel, and shall for sixty per cent (60%) of its bulk be uniformly graded between the diameters of one (1) and one and one-half (1½") inches, and for forty per cent (40%) of its bulk be uniformly graded between diameters of one-quarter (¼) and one (1") inch. A hard crushed trap rock may be substituted or gravel if screened to meet the requirements indicated.

4. Mixing—The dry mixture of cement, sand and stone in the above proportions shall be tempered to a medium wet consistency with water to which one (1) part of TRUSCON Waterproofing Paste, Concentrated, has been added as directed by the manufacturers, for every thirty-six (36) parts of water.

5. Placing—All the concrete shall be placed in one continuous operation, each pouring being thoroughly spaded to insure uniform density. In cases where joints are absolutely unavoidable, very special care shall be taken to clean and roughen the old surface and have it thoroughly wet and slush-coated immediately before placing additional concrete.

Diagram Illustrating the Waterproofed Cement Plaster Coat



Waterproofing Concrete or Masonry by Means of Waterproofed Plaster Coat Applied to Interior Surfaces. Observe how Wall Plaster Coat and Cement Floor Finish are joined. For details, see page **30**—"Making the Plaster Coat Continuous."

Note:—Enlarged view in upper right hand corner shows method of routing out surface at juncture of Wall Plaster Coat with Floor Cement Finish and insertion of chicken wire mesh as corner reinforcing for waterproofed plaster.

SPECIFICATIONS

For Waterproofing Concrete and General Masonry Structures by Means of Waterproofed Plaster Coat

Applicable to Cisterns, Reservoirs, Foundations, Basements, Tunnels, Subways and Similar Structures

For Suggestions on Practical Application, see Page 25

1. Intent—It is the intent of these specifications to obtain a water-tight structure.

2. Method—Water-tightness shall be secured by plastering the interior surface of the structure with a continuous coat of Portland cement mortar waterproofed with TRUSCON Waterproofing Paste, Concentrated, as manufactured by THE TRUSCON LABORATORIES, Detroit, Michigan.

3. Ingredients and proportions of Waterproofed Plaster Coat—The mortar composing the plaster coat shall consist of one (1) part of cement and two (2) parts of sand, to meet the following requirements:

   (a) The cement shall be a high grade Portland, which has been carefully tested and found to satisfactorily meet the requirements of the Standard Specifications of the American Society for Testing Materials and preferably ground so that eighty per cent (80%) shall pass a standard two hundred (200) mesh sieve.

   (b) The sand shall consist of spherical grains of any hard rock that is practically free from clay, absolutely free from organic matter, and uniformly graded in size from coarse to fine.

4. Preparation of the Coating—The waterproofed cement mortar shall be prepared by thoroughly tempering (to required consistency) a dry mixture of one (1) part of cement and two (2) parts of sand, with water to which TRUSCON Waterproofing Paste, Concentrated, has been added in the proportion of one (1) part of Paste to eighteen (18) parts of water, as directed by the manufacturers.

5. Preparation of Surface to be Coated—Before plastering the cement mortar on the hardened concrete, the surface of same shall be treated as indicated in the following:

   (a) The hardened surface shall be mechanically roughened by chipping and very thoroughly cleaned with a heavy wire broom, so as to remove all dust and dirt. A jet of steam shall be employed to clean the wall, if available.

(b) To the mechanically cleaned surface apply with a large acid brush a liberal coat of one to ten (1:10) solution of Hydrochloric Acid (Muriatic Acid). Allow the acid to remain until it has exhausted itself, which will require at least ten minutes. Apply a second coat of acid solution if the first does not sufficiently clean and expose the surface of the aggregate.

(c) With a hose under good pressure, slush the surface so as to remove the salts and loose particles resulting from the action of the acid. Continue the slushing until the old concrete is thoroughly cleaned and soaked to its full hydrometric capacity. Thoroughly wire-brush the surface so as to remove the particles which have been loosened by the action of the acid.

(d) To the cleaned, saturated surface apply with a strong fibre brush a coating of pure cement mixed to a thick, creamy consistency with water to which TRUSCON Waterproofing Paste, Concentrated, has been added in the proportion of one (1) part of Paste to eighteen (18) parts of water. Rub in vigorously so as to fill all crevices and cavities produced by the action of the acid.

6. Application of Coating to Sides—Immediately after applying the above slush coat, the first coat of waterproofed cement mortar shall be applied to a thickness of three-eighths of an inch (3/8") directly on the slush coat, and well trowelled and rubbed into the crevices of the surface. The first coat shall be lightly scratched before showing initial set. Before this coat has reached its final set, the second coat shall be applied, of equal thickness, so as to give a full average thickness of three-quarters of an inch (3/4"). Most special care shall be exercised to apply this finish coat before the first coat has reached its final set. The finish coat shall be thoroughly floated to an even surface and subsequently trowelled free from any porous imperfections.

7. Floor Coating—The floors shall be prepared and treated exactly as indicated above, and finished with a waterproof cement mortar to a thickness of two inches (2"). Special care should be exercised to bond the wall coating to the floor coating, so as to make the waterproofed coating continuous over the entire surface.

8. Pressure—(See "Relieving Water Pressure," page 25)—Where water is running through the wall, proper drainage must be provided by drilling holes and inserting tubes in the wall, to concentrate the flow of water. With the pressure relieved, the waterproofed plaster coat shall be applied to the drained portions of the wall. The drainage pipes shall remain open until the waterproofed plaster coat has thoroughly set and is capable of resisting the pressure of its own adhesive strength, when the drainage pipes shall be closed with suitable plugs and overcoated with the waterproofed cement mortar.

SPECIFICATIONS

For Waterproofing Cement Stucco

1. Intent—It is the intent of these specifications to obtain a sound, permanent and waterproof stucco.

2. Materials—The materials composing the stucco shall consist of:

(a) Portland cement which has been carefully tested and found to satisfactorily meet the requirements of the Specifications of the American Society for Testing Materials.
(b) Sand which is practically free from organic matter and uniformly graded in size from coarse to fine.
(c) Hydrated lime that is uniform in quality and perfectly hydrated.
(d) TRUSCON Waterproofing Paste, *Concentrated*, as manufactured by THE TRUSCON LABORATORIES, Detroit, Michigan.

3. Proportions—The proportions of the above specified materials by volume, shall be five (5) parts of cement, twelve (12) parts of sand, and one (1) part of hydrated lime. One (1) part of Truscon Waterproofing Paste, *Concentrated,* shall be added to every eighteen (18) parts of water used to temper the mortar.

4. Mixing—The cement and hydrated lime, after being thoroughly mixed dry to uniform color, shall be added to the dry sand and the whole manipulated until evenly mixed. The dry mixture shall then be tempered to the correct working consistency with water to which TRUSCON Waterproofing Paste, *Concentrated,* has been added in proportion specified. The mortar must be thoroughly worked until perfectly homogeneous. This composition shall only be made up in lots that can be immediately applied, and any material that has been mixed with water over thirty (30) minutes before applying shall be rejected.

5. Application—All walls shown on elevation for stucco finish shall be two-coat work. The first coat shall be prepared as specified above, with the addition of long cow hair for keying when applied to metal lath. The face of the first coat shall be thoroughly scratched over to form a key for the finish coat, which shall be applied to a

total thickness of one inch (1″), when the first coat has set sufficiently hard to safely hold it. The finish coat shall be carefully floated from any porous imperfections.

When plastering over a masonry surface, special care must be taken to thoroughly saturate the masonry with water and the plaster applied at once.

6. Drying—Special care shall be taken to avoid too rapid drying. If in direct rays of the sun, the stucco shall be protected with a damp canvas or burlap, and when sufficiently resistant, shall be frequently sprinkled with water.

7. No exterior plastering shall be permitted until all interior partitions are studded up and completely braced.

Proportions of Truscon Waterproofing Paste, Concentrated, for Various Methods of Waterproofing

For general information relative to the quantities of Waterproofing Paste, Concentrated, to be used for various concreting operations, we are presenting the following data.

Mass Concrete

In mass concrete using 1:2:4 mix under normal conditions of exposure, 1 part of Paste to 36 parts of water is our standard recommendation. In occasional operations where the requirements are very particular and exacting, this should be changed to 1 part of Paste and 24 parts of water for 1:2:4 concrete.

In using Truscon Waterproofing Paste, Concentrated, the exact amount required to the cubic yard of concrete varies somewhat with the amount of water used. We recommend, however, that the quantity of 7 lbs. of Paste per cubic yard be considered a standard in estimating requirements for this material when it is used in the proportion of one part of Paste to thirty-six parts of water.

Plaster Coat and Cement Stucco

For 1: 2 plaster coat or cement stucco, Truscon Waterproofing Paste, Concentrated should be added in proportions of 1 Part of Paste to 18 parts of water. Plaster coat on the wall or stucco should be at least ¾″ thick. This requires 6

lbs. of Paste per 100 sq. ft. The floor topping should be applied 2″ thick. This requires 16 lbs. of Paste per 100 sq. ft.

For the waterproofed cement plaster coat, using proportions of one part of Paste to 18 parts of water, the following table gives the quantities of cement, sand, and Truscon Waterproofing Paste, Concentrated, required for the 1:2 waterproofed plaster coat to cover 100 sq. ft. of surface. The same proportions of Truscon Paste given in the last column also applies to Cement Stucco.

Proportions	Thickness	Bbls. Cement	Cu. Yds. Sand	Lbs. Paste
	2″	2.00	.56	16
1 part Cement....	1½″	1.50	.42	12
2 parts Sand.....	1″	1.00	.28	8
Area 100 sq. ft...	¾″	0.75	.21	6
	½″	0.50	.14	4

How to Obtain Proper Proportions

The best results are obtained by thoroughly mixing one part of Paste with an equal volume of water and while stirring vigorously, adding sufficient more volumes of water to give the required proportions. In case the mixture of Paste and water is allowed to stand for an interval between using, it should be stirred to insure an even uniform mixture. The Paste diffuses so readily that this imposes no additional trouble. Very little stirring will insure perfect distribution.

Practical Application of the Waterproofed Plaster Coat

While the application of the Waterproofed Plaster Coat is a comparatively simple procedure, in practical operation it is nevertheless necessary to observe carefully several very important points.

These points in their proper order are as follows:

(1) Relieving water pressure during application and setting of Plaster Coat. (Page 25)

(2) Proper roughening of the surface to insure good bond for the Plaster Coat. (Page 28)

(3) Thorough wetting of wall before applying grout coat. (Page 29)

(4) Proper floating and troweling to insure absence of voids and porous imperfections. (Page 29)

(5) Making the Plaster Coat continuous. (Page 30)

(1) Relieving water pressure during application and setting of Plaster Coat.

This is of first importance among the precautions referred to, because it would certainly be impractical to allow the cement coating to be washed away before it has had a chance to

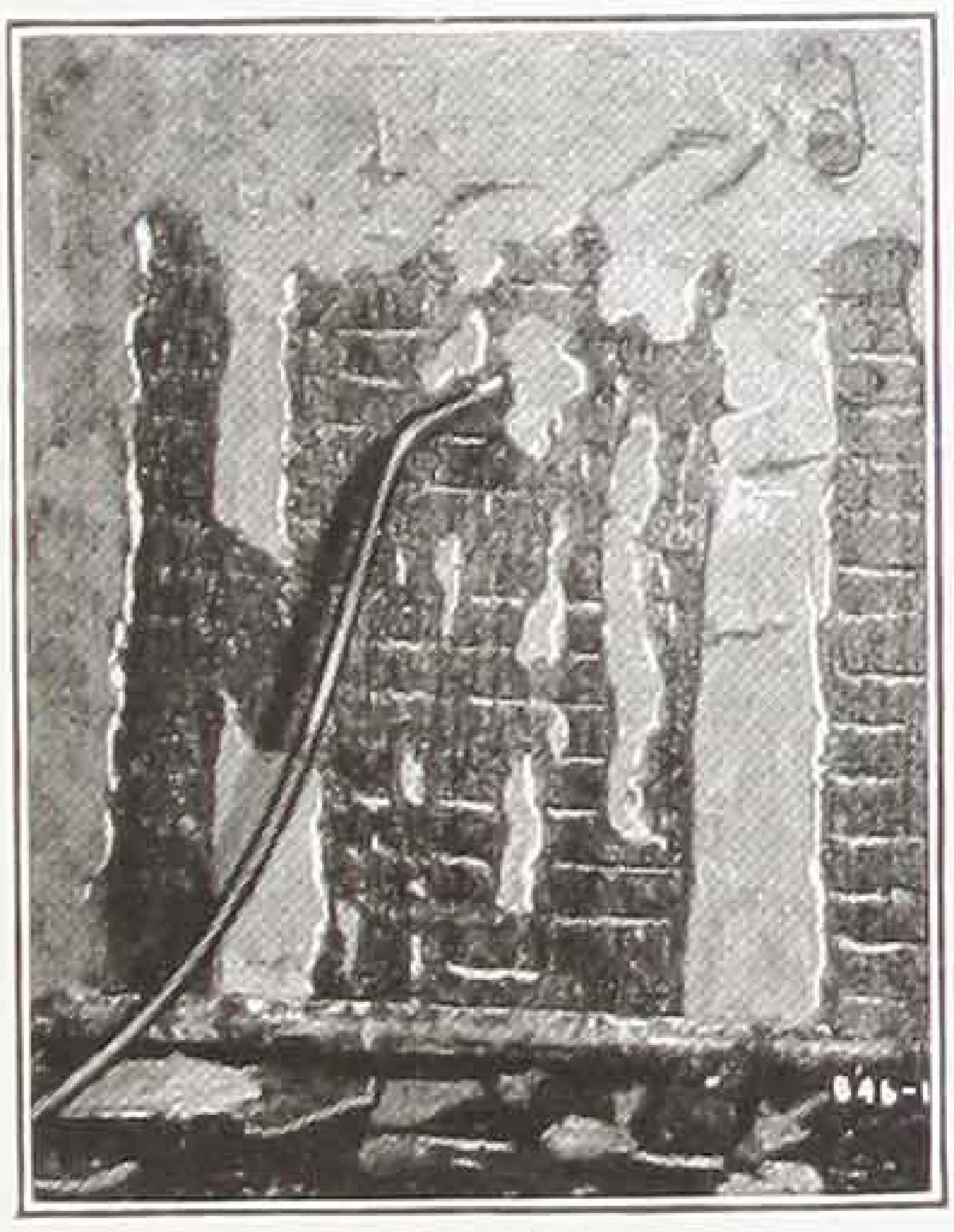


Fig. 1

Result of ignoring the importance of relieving water pressure behind a masonry wall prior to applying Plaster Coat.

harden and set. As an example, Figure 1 illustrates a section of a brick wall over which an attempt has been made to apply a Plaster Coat

on a surface where there was a slow seepage of water. While to the naked eye the movement of water was hardly discernable, yet as soon as the green Plaster Coat was applied it began to be carried down on the thin film of moisture that slowly but positively collected in back of the Plaster Coat and separated it from its contact with the surface. The streaked appearance of the wall in the photograph illustrates this point. It was necessary to insert the bleed pipe, as shown, to concentrate the flow of water before the Plaster Coat could be applied further.

It is evident, therefore, that proper provision must be made for taking care of water pressure on a surface to be Plaster Coated. In the case of basements this is sometimes done by the very simple expedient of taking a post hole digger and sinking a hole on the outside of the wall opposite the place where the seepage seems to concentrate. Then by pumping out the water the pressure is relieved sufficiently to allow the work to proceed.

Fig. 2

Illustrating the extent to which it is sometimes necessary to use bleed pipes to relieve water pressure before applying Plaster Coat.

However, for general purposes probably the most practical method and the one which is most generally used is by the insertion of bleed pipes through the wall. An example of this is illustrated in Figure 1 already referred to, and is shown again on a somewhat larger scale in Figure 2. Holes were drilled through the wall, into which the bleed pipes were inserted and the Plaster Coat applied. After thorough hardening of the Waterproofed Plaster Coat, the bleed pipes are broken off and closed by driving in pine

plugs. Waterproofed cement can be applied over the plugged holes so as to give a uniform appearing surface.

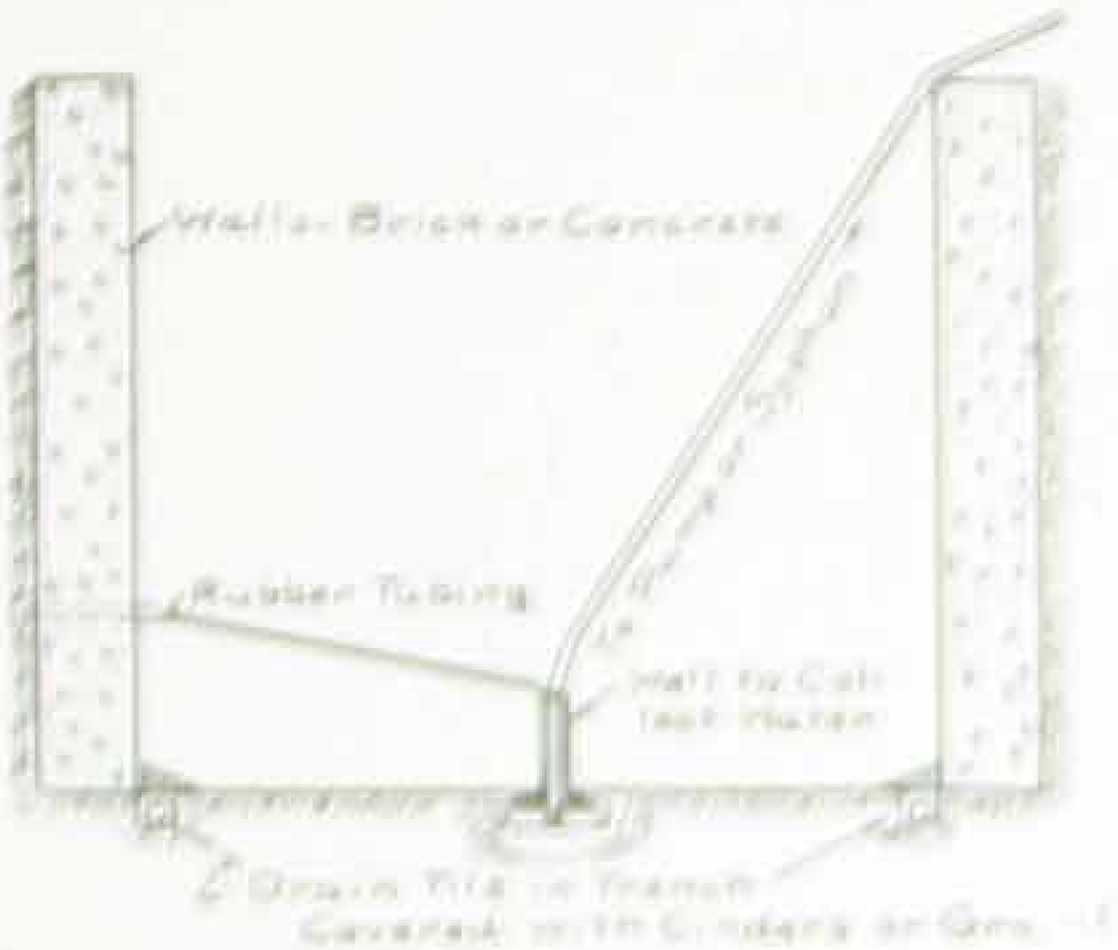


Fig. 3

Figure 3 illustrates a section of a wall demonstrating the idea of relieving seepage. To relieve the pressure on the wall at the left a hole has been drilled through the wall, into which has been inserted a pipe, which is then made continuous with a sump construction in the center of the excavation. It also illustrates the erection of a 2 inch drain tile in a trench around the foot of the wall which is constructed to grade so as to empty into the sump from which the water is relieved by means of a syphon pump.

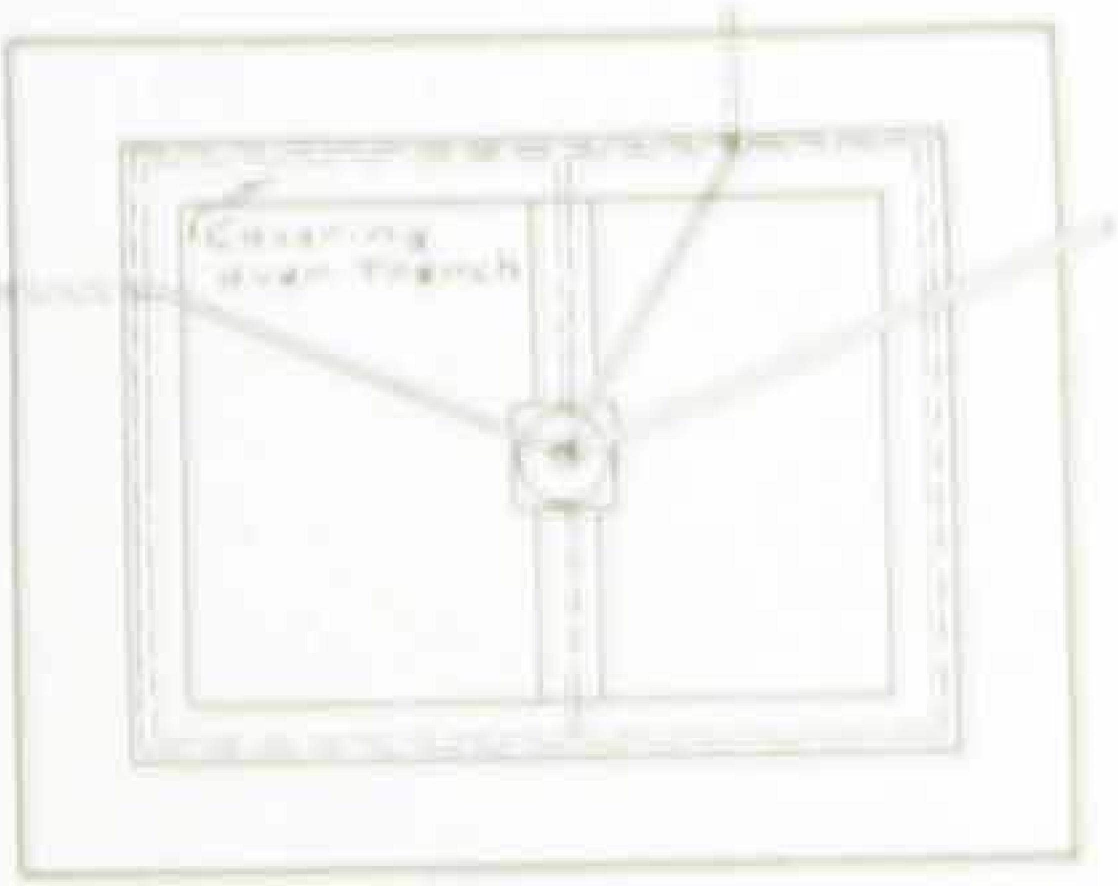


Fig. 4

Figure 4 is a plan of the condition illustrated in Figure 3. Observe the two bleed pipes inserted in the walls which are connected with a syphon pump, and the presence of the drain tile which is covered with cinders and gravel running continuously on the outside and connected to the central sump. With the flow of water concentrated to the sump in this manner, the surface is

in condition for application of the Plaster Coat. The bleed pipes should be left for a period of ten days or two weeks in order to insure the proper hardening of the Plaster Cost before it is required to withstand pressure.

(2) Proper roughening of the surface for the Plaster Coat.

Of as much importance as relieving the water pressure from behind the waterproofed Plaster Coat while hardening, is the preparation of the surface for the proper reception and bonding of the Plaster Coat. Naturally it is more difficult to bond a Plaster Coat to a smooth surface than to a rough surface. For this reason the wall must be roughened sufficiently to give a good "key" to the

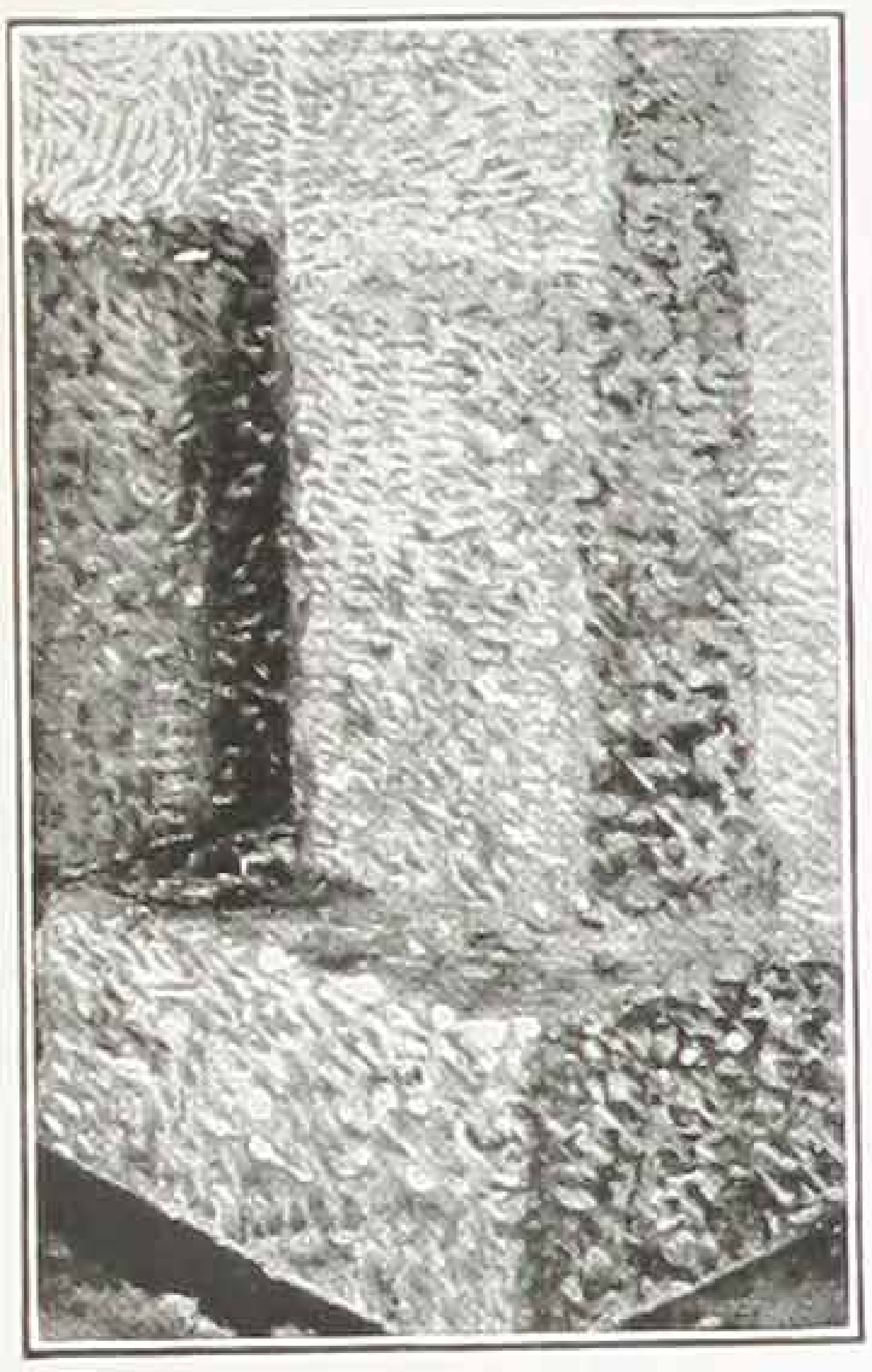
View showing a concrete surface under course of preparation for the receipt of the waterproofed Plaster Coat. The entire face is removed to expose the aggregate, the workman now being engaged in going over those spots which were missed in the first operation. Note how carefully the surface is prepared even around columns and footings, so as to insure a continuous waterproofed Plaster Coat.

Fig. 5

plaster. In Figure 5 is illustrated the manner of chipping and roughening a concrete wall. In Figure 6 is shown how the roughening treatment is applied to columns and footings. In the case of a brick wall, pains are taken to rake out the mortar to a depth of fully half an inch in between the joints so as to afford the right kind of a bond for the Plaster Coat. A stone wall should be similarly cleaned and roughened (chiseled) previous to applying the Plaster Coat.

After the surface has been thoroughly roughened, it should be cleaned with a heavy wire broom to remove all loose particles. If a jet of steam is available it should be used to clean the wall. Truscon Specifications (page 19) are very clear on this point, as well as on the use of dilute muriatic acid. The whole purpose of all this preparation is simply to be absolutely positive

that the Plaster Coat is able to adhere securely to the wall without the slightest danger of becoming separated therefrom.



Closeup view of column and footings. Too great importance for 100% efficiency of a waterproofing job cannot be placed on carrying the Plaster Coat around the columns and the proper roughening of such columns for the reception of the Plaster Coat.

Fig. 6

(3) Thorough wetting of wall before applying grout coat.

After the second treatment of acid solution has been applied as directed in Specifications (page 20) and the surface has been slushed freely to remove all loose particles and salts resulting from the action of the acid—one should continue slushing the old concrete or masonry wall until it is soaked to its full hydrometric capacity. The purpose of soaking the wall is to give the masonry all the water it can absorb so that it in turn will not rob the Plaster Coat of any of its water. So often is this mistake made in cement work, of refusing to recognize the strong water absorptive characteristic of masonry and the fact that cement in order to set must have an abundance of water. If the cement while setting is robbed of any of its water the result will be a poor job, usually soft and crumbly cement or cracks. Immediately following the thorough soaking above referred to, apply the grout coat described on page 20 of the Specifications, paragraph 5-D.

(4) Proper floating and troweling to insure absence of voids and porous imperfections.

Greater care must be taken in the application of a waterproofed Plaster Coat than in the application of ordinary plaster. The material should

be firmly pressed and worked into all crevices and mechanical irregularities of the surface and then well floated. This is the part of the job that really requires some skill and experience. It can probably best be described by saying that the Plaster Coat must be "compressed" on the surface, as well as trowelled, in order to give it the necessary density for thorough waterproofing results.

(5) Making the Plaster Coat continuous.

Water follows the line of least resistance. If, for example, water appears to be seeping through the floor of a basement only, it is not good practice to be content with applying a 2-inch Waterproofed Cement Finish to the floor, and expect the basement to be waterproof. Because, water finding its passage obstructed at the floor, will simply work its way around, and probably make its appearance somewhere through the walls. This has been so repeatedly demonstrated that we urgently recommend never to attempt waterproofing the floors without at the same time waterproofing the walls, or vice versa.

A ¾-inch Plaster Coat as recommended in these Specifications should be used on all walls of structures it is desired to waterproof, and it is advisable to run this Plaster Coat to at least A FOOT ABOVE GRADE LINE. A 2-inch waterproofed cement finish should be applied to the floor, making the finish continuous with the Plaster Coat so that there is no opportunity for water to force its way through a possible joint. For this reason the floor at its point of juncture with the wall is routed out a little deeper. See detail of floor-wall corner in diagram on page 18. Note how the floor and wall has been routed into, and the Plaster Coat applied. Also note the fillet made at the junction of the Plaster Coat with the Cement Finish. Especially interesting also is the insertion of the strip of chicken wire into the corners. The purpose of this is to act as a reinforcing at the junction of the wall and floor. As can be seen the chicken wire should be run about 8 inches up the wall and the same distance into the floor. This practice is not always adopted and may not be called a necessity, although from an engineering point of view it is a very desirable feature, especially since the small amount of wire

mesh used is comparatively inexpensive and the reinforcing it gives very valuable.

The same recommendations apply to waterproofing columns set into the floor. If there is a brick or concrete column the Plaster Coat should be run around the footings and up the column to the same height the Plaster Coat is run up the walls, so as not to allow the slightest opportunity for water seepage through capillary action in the columns.

Continuity of the Plaster Coat and Floor Finish is so important that the formation of distinct joints between successive applications should be carefully avoided. If possible, each coat of the Plaster Coat should be applied without interruption. However, where it is necessary to leave off work, care should be taken to skive off the Coat to a chisel edge, so that the "joint" will be made at an acute angle. (See Figure 7.) On resuming work, the skived section of the old Plaster Coat

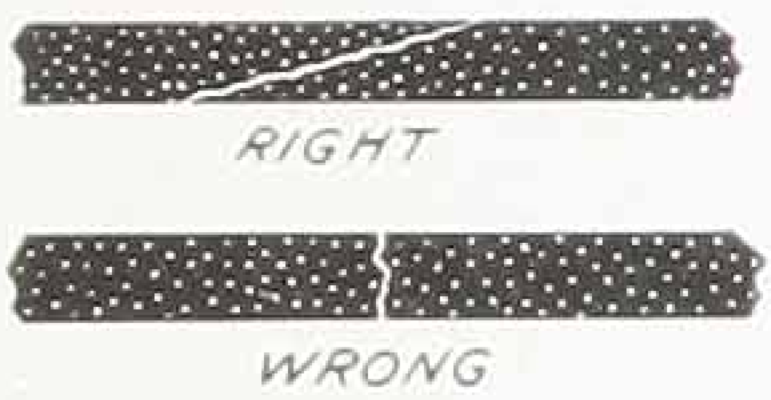


Fig. 7

The upper diagram shows the correct method of continuing a Plaster Coat where it has been necessary to leave off work and resume at another time. The lower cut shows how this work should not be done, as it leaves too distinct a joint through which seepage could occur.

should be roughened and thoroughly saturated with water. As a matter of fact, thorough wetting of the surface over which a Plaster Coat is applied, as already pointed out, is always advisable. It prevents too rapid drying out and shrinking of the Plaster Coat.

Fig. 8 (Page 33) is interesting in that it shows how the Waterproofed Plaster Coat should be handled to take care of the particular conditions met with in practical work. Observe how the Waterproofed Plaster Coat was run UNDERNEATH the concrete column, although the alternate method of running same up the column could have been adopted. Observe further how the Plaster Coat takes care of the waterproofing around the steel column with grillage footing thereby preserving the same against the action of electrolysis. The method of waterproofing the boiler pit by running the Plaster Coat between

the concrete base and the fire brick construction is also worthy of attention. This entire illustration emphasizes the perfect CONTINUITY of the Plaster Coat, which is so essential to permanent waterproofing results.

While a 2-inch Cement Finish only is mentioned in our Specifications for waterproofing a floor, and while oftentimes for reasons of special economy where the hydrostatic head is small this may be cut down to 1½ inches or even an inch—yet on the other hand there are extreme conditions where this Floor Finish must be increased to 3 or 4 inches.

A case in point would be in the event of a wide span of floor surface subjected to 4 or 5 feet of hydrostatic head over which floor surface a rather thin concrete base had originally been laid, say about 6 inches. Upon applying a waterproofed Cement Finish over this it would be discovered that the strain on that floor as the result of the confined water pressure underneath would be so great as to probably cause structural cracks in the floor. In that case it would be necessary to increase the "dead weight" of the Plaster Coat by increasing its thickness and probably even by reinforcing it with steel bars. Wherever such a condition is encountered it is our recommendation that a competent engineer be called in to determine the hydrostatic head and to recommend the proper thickness of the Plaster Coat, reinforcing, etc.

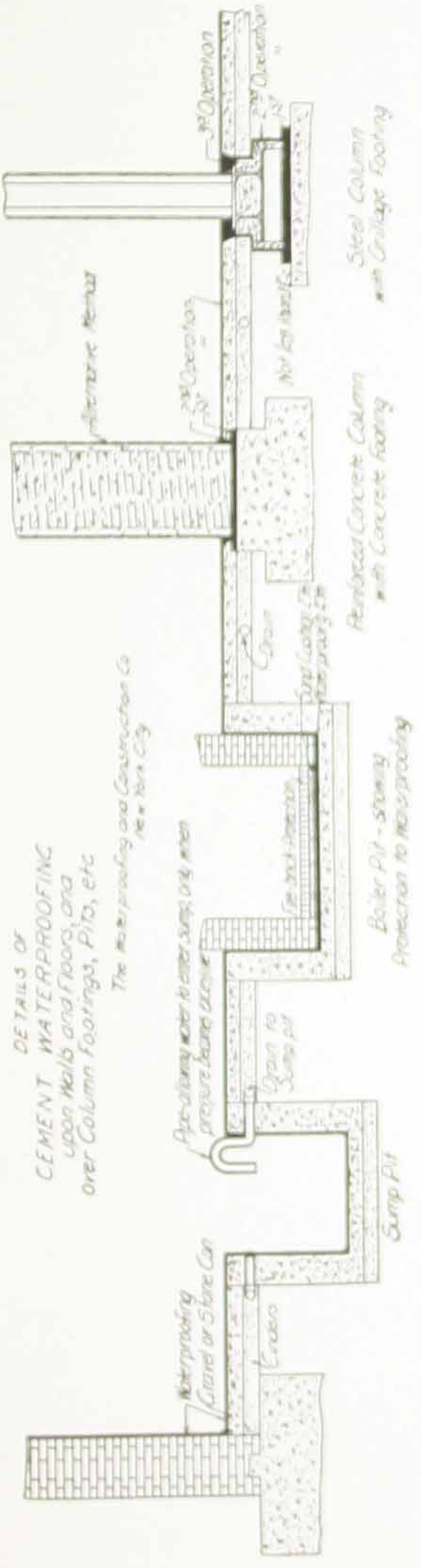

DETAILS OF
CEMENT WATERPROOFING
upon Walls and Floors, and
over Column Footings, Pits, etc
The Waterproofing and Construction Co
New York City
Steel Column
with Grillage Footing
Reinforced Concrete Column
with Concrete Footing
Boiler Pit - showing
Protection to Waterproofing
Sump Pit
Drain to
Sump pit
Waterproofing
Cinders
Alternate Method
1st Operation
2nd Operation

Fig. 8